Wind Farm Noise
Cumulative Impact Assessment

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Cumulative Impact Assessment

- ETSU-R-97

"The Noise Working Group is of the opinion that absolute noise limits and margins above background should relate to the cumulative effect of all wind turbines in the area contributing to the noise received at the properties in question. It is clearly unreasonable to suggest that, because a wind farm has been constructed in the vicinity in the past which resulted in increased noise levels at some properties, the residents of those properties are now able to tolerate higher noise levels still. The existing wind farm should not be considered as part of the prevailing background noise."

HOARE LEA ACOUSTICS

Cumulative Impact Assessment

- Background noise levels (from which noise limits are derived) should not include any wind turbine noise
- Derived noise limits should apply to all wind farm noise

HOARE LEA ACOUSTICS

Background Noise Levels

- New wind farm adjacent to an existing one
  - Previous wind farm ES survey results
  - New surveys filtered to exclude effects of existing wind farm
- New wind farm adjacent to another not built
  - New surveys can be undertaken

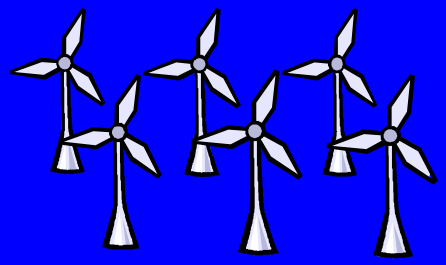
HOARE LEA ACOUSTICS

Wind Farm Noise Levels

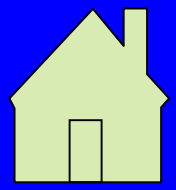
- Wind farm A gets consent with a 40dB(A) lower day-time fixed limit
- Wind farm B gets consent with a 40dB(A) lower day-time fixed limit
- Each wind farm meets the limit and for some properties cumulatively this could be 43dB(A)
- Wind direction?

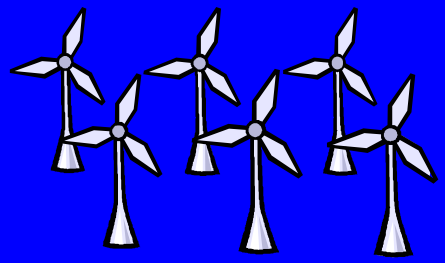
HOARE LEA ACOUSTICS

Scenario I



A





B

Downwind of A = Upwind of B

=

No cumulative impact

(% time exposed)

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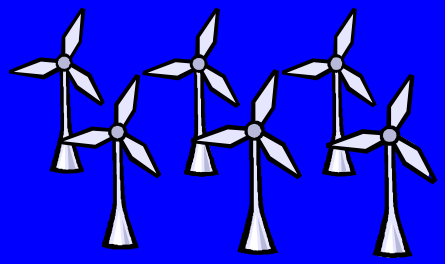
Scenario II

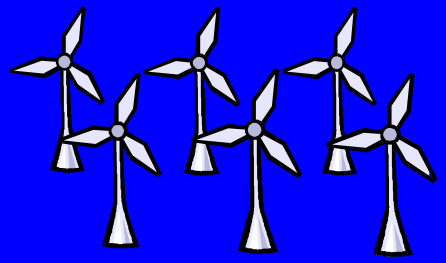


A

Downwind of A = Crosswind of B

=

Cumulative impact?



B

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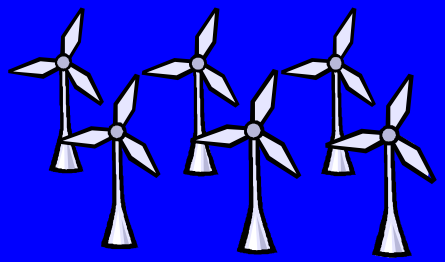
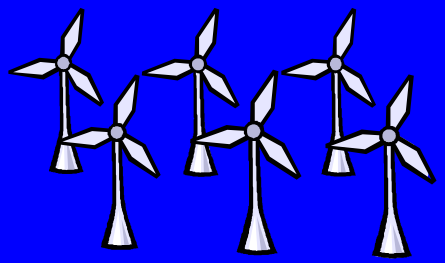
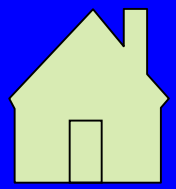
Scenario III



A



B

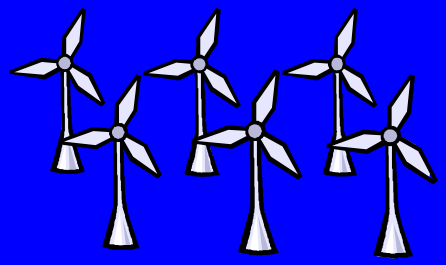


A is near, B is far

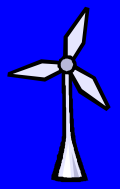
=

Cumulative impact?

Scenario IV

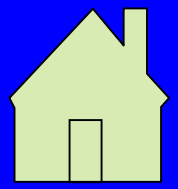


A

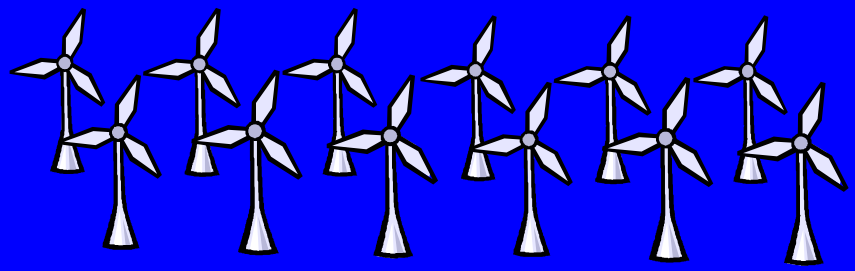


B

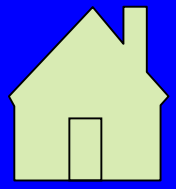
A is far away & large,
B is small & near
=
Cumulative impact?



Scenario V



A B



A & B adjacent

=

Cumulative impact?

Cumulative Issues

- Background noise surveys
  - Different results for the same location?
  - Numerous met masts in different locations at different heights?
- Different turbine hub heights?
- Derived noise limits
  - Involved occupier for one scheme, uninvolved for the other
  - 40dB(A) fixed limit for one wind farm
    35dB(A) for the other

HOARE LEA ACOUSTICS

Cumulative Issues - Resolution

- All noise data could be correlated with 10m wind speeds calculated from those at hub height. Wind speeds at hub height are likely to be similar between sites for a given hub height than those directly measured at 10m.
- The same noise limits could be applied regardless of wind farm. Discussions with the LPA should determine a ‘reasonable’ approach to choosing appropriate background data.

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Cumulative Issues - Resolution

- Noise limits could apply to the ‘total’ cumulative noise levels. This may entail reduced noise limits for each site.
- The same noise limits (35 to 40) could be applied to cumulative noise levels
- If the limit is for an involved occupier (45dB) this could be applied to cumulative noise levels

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When to Consider Cumulatively

- Take predicted noise levels in the ES
- Calculate the combined noise levels at each location assuming all locations downwind of all turbines
- Determine relevant contributions
- Cumulative impact should be considered if
  - Total noise levels are 1dB(A) greater than individual
  - Location is not directly up-wind of one wind farm when downwind of another (≠ scenario I)

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What's the Solution?

- Cumulative locations
  - Normal limit where no cumulative effects
  - Reduced limit where there are cumulative effects
  - Wind direction dependant
- Other locations
  - Apply noise limits individually to each site in the normal way

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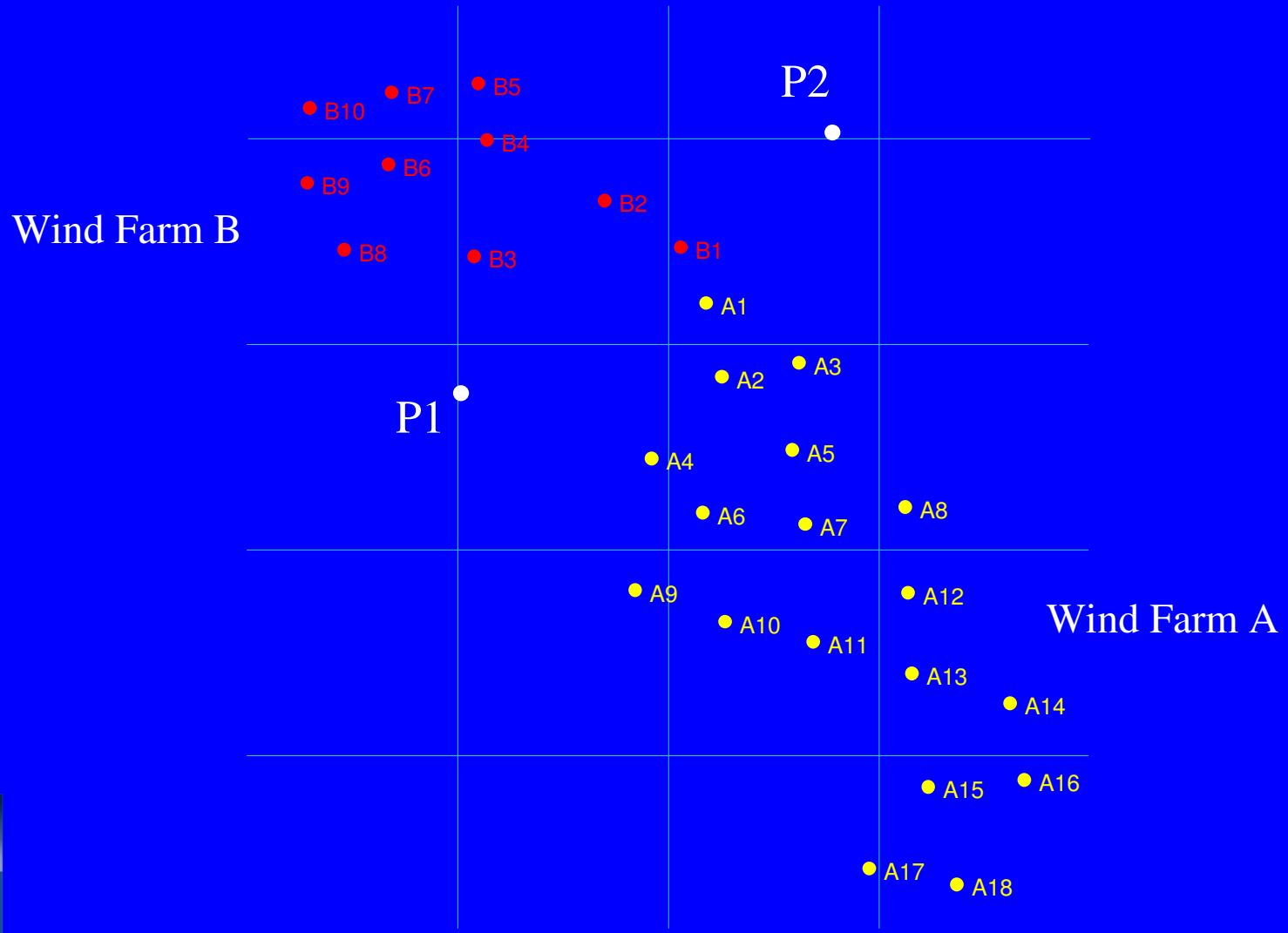
Real Example



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ES Assessment Differences

- Background noise
  - Different levels at low wind speeds & different relationship with change of wind speed
- Both surveys were correlated against 10m masts 3.2km apart
- Different times of the year
  - Seasonal variations in traffic levels
  - Trees in leaf
- Rainfall exclusions
- Noise data filtered by direction to remove traffic noise influence

HOARE LEA ACOUSTICS

Cumulative Assessment Method

- Simplified
  - Apply the same noise limit to each wind farm
  - Consider only the noise limits, not turbine noise
  - Consider only a single wind speed
- Set-up Noise Model
  - ISO9613
  - Frequency spectra for each site based on ‘candidate’ turbine choice
  - Assume a directivity function

HOARE LEA ACOUSTICS

Cumulative Assessment Method

- Find the wind heading giving the maximum noise level from each individual wind farm
- Calculate the sound power levels needed for the turbines on each site to individually achieve the noise limit (40dB(A) in this case)

HOARE LEA ACOUSTICS

Cumulative Assessment Method

- Calculate the individual and cumulative noise levels by wind heading
- Calculate the maximum cumulative increase in noise levels compared to the individual contribution
- Apply a reduction of this amount to each wind farm over sufficient wind headings so that cumulative noise levels meet the limit (40dB(A) in this case)

HOARE LEA ACOUSTICS

What Wind Headings?

- Change of propagation with wind heading
  - Source directivity
  - Propagation directivity
- Assume a combined directivity function which includes both aspects.
- What values should we use?
  - Guesstimate!
- 4 different functions have been considered

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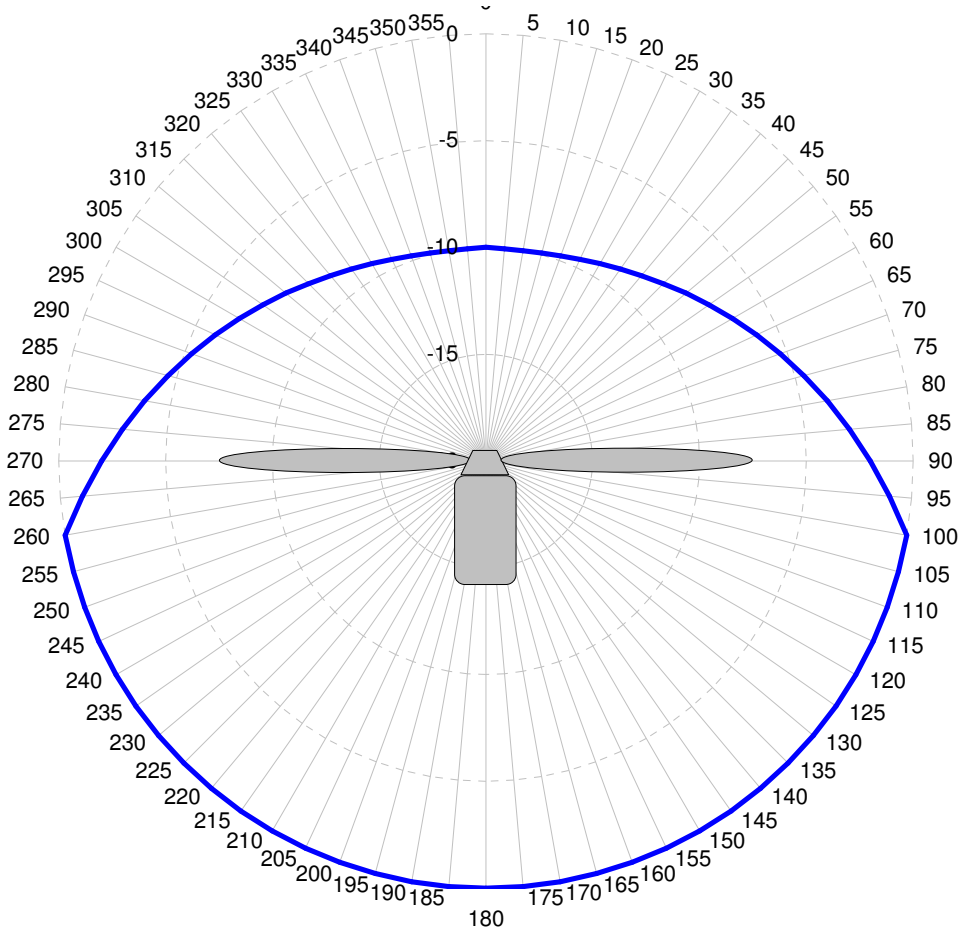
Directivity Function 1



Direction	Attenuation
0	-10.0
15	-9.9
30	-9.3
45	-8.3
60	-6.7
75	-4.6
90	-2.0
105	0.0
120	0.0
135	0.0
150	0.0
165	0.0
180	0.0
195	0.0
210	0.0
225	0.0
240	0.0
255	0.0
270	-2.0
285	-4.6
300	-6.7
315	-8.3
330	-9.3
345	-9.9
360	-10.0

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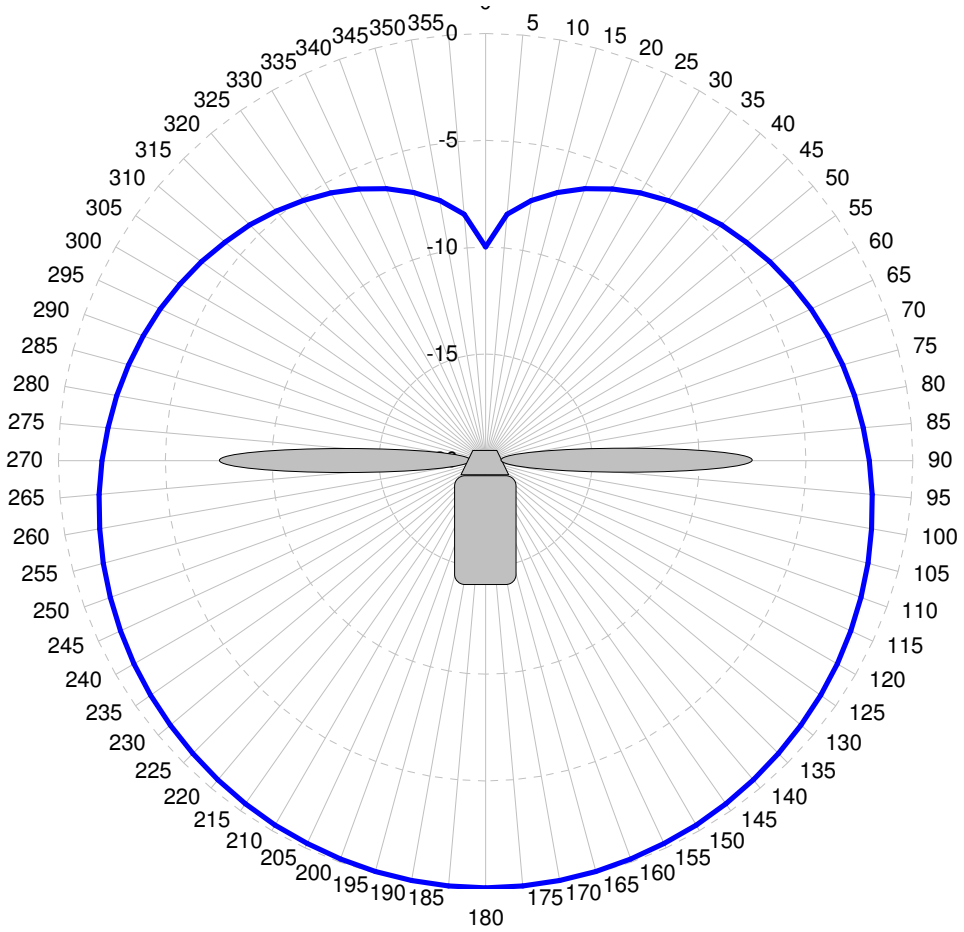
Pessimistic and based on PPG24 & ISO9613

Directivity Function 2



Direction	Attenuation
0	-10.0
15	-7.0
30	-5.5
45	-4.4
60	-3.5
75	-2.7
90	-2.0
105	-1.5
120	-1.0
135	-0.6
150	-0.3
165	-0.1
180	0.0
195	-0.1
210	-0.3
225	-0.6
240	-1.0
255	-1.5
270	-2.0
285	-2.7
300	-3.5
315	-4.4
330	-5.5
345	-7.0
360	-10.0

Less pessimistic and perhaps more realistic (Bowdler)

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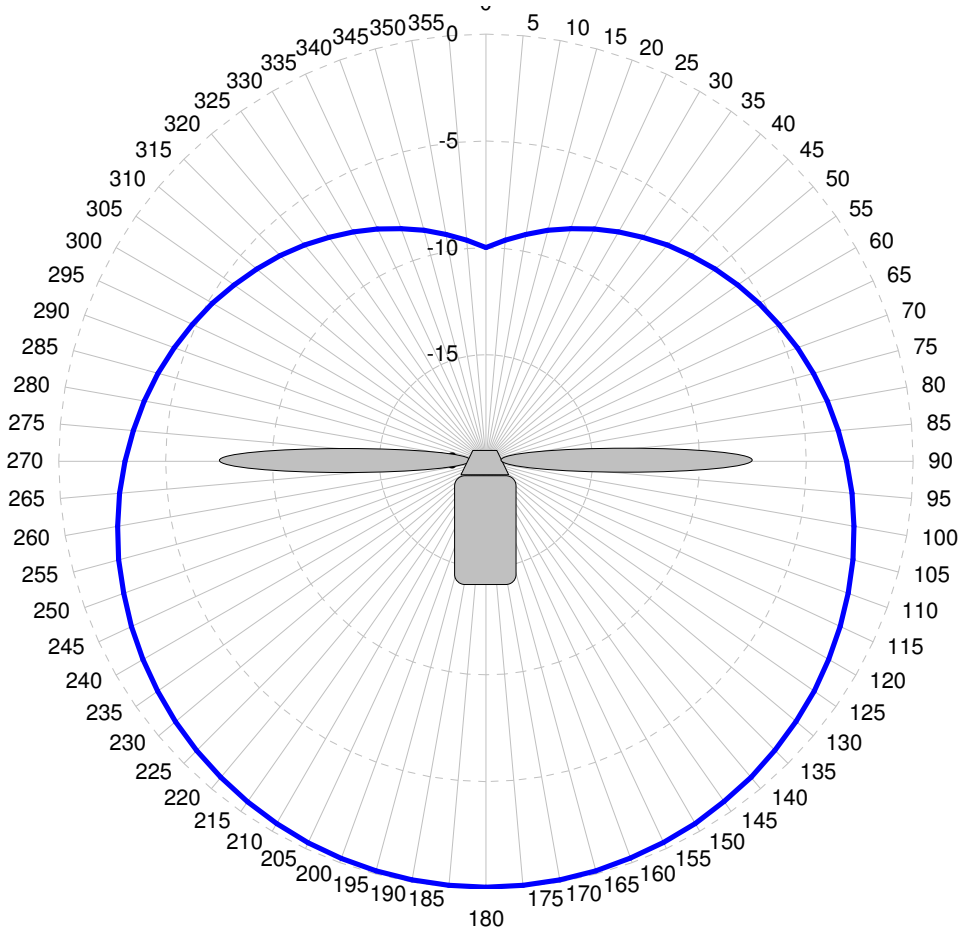
Directivity Function 3

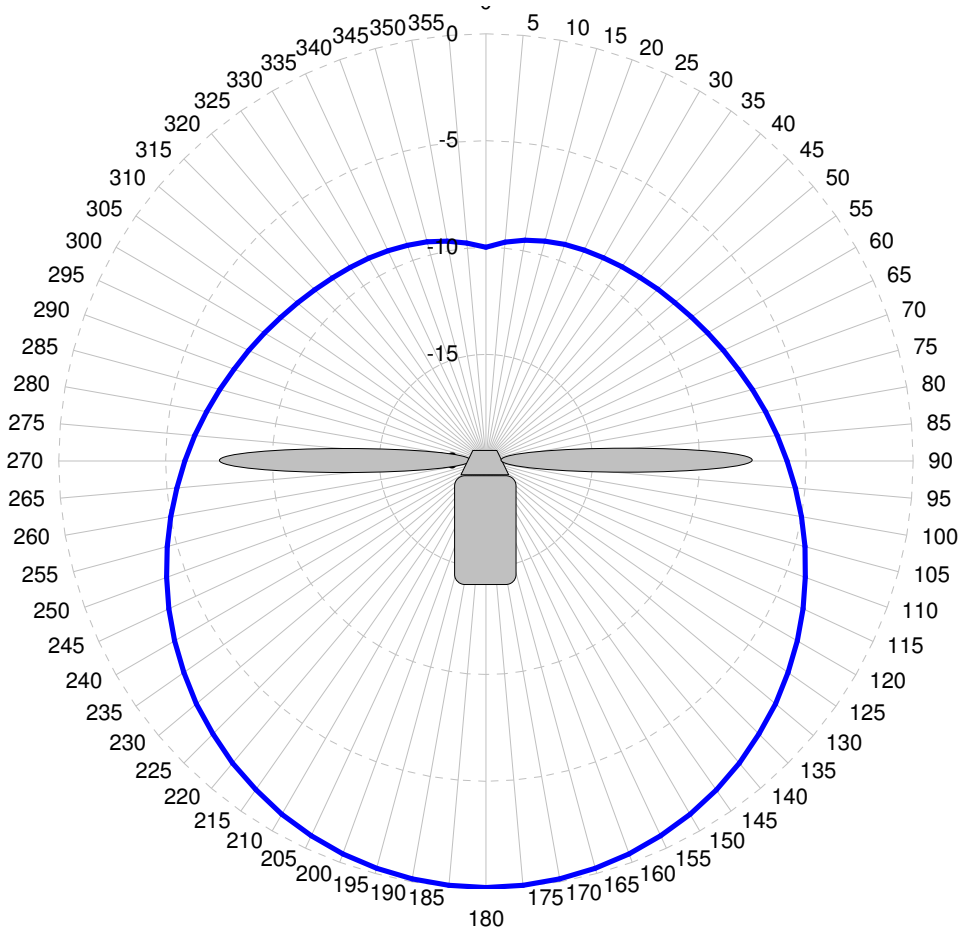


Direction	Attenuation
0	-10.0
15	-8.8
30	-7.6
45	-6.4
60	-5.2
75	-4.1
90	-3.1
105	-2.2
120	-1.5
135	-0.9
150	-0.4
165	-0.2
180	0.0
195	-0.2
210	-0.4
225	-0.9
240	-1.5
255	-2.2
270	-3.1
285	-4.1
300	-5.2
315	-6.4
330	-7.6
345	-8.8
360	-10.0

HOARE LEA ACOUSTICS

Also less pessimistic – marginally relative to #2

Directivity Function 4



Direction	Attenuation
0	-10.0
15	-9.3
30	-9.0
45	-8.6
60	-8.0
75	-7.1
90	-5.9
105	-4.5
120	-3.2
135	-1.9
150	-0.9
165	-0.3
180	0.0
195	-0.3
210	-0.9
225	-1.9
240	-3.2
255	-4.6
270	-5.9
285	-7.1
300	-8.0
315	-8.7
330	-9.0
345	-9.4
360	-10.0

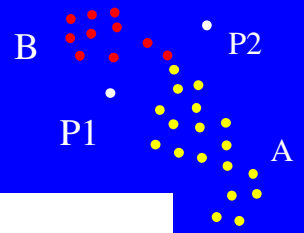
Much less pessimistic – may not be realistic

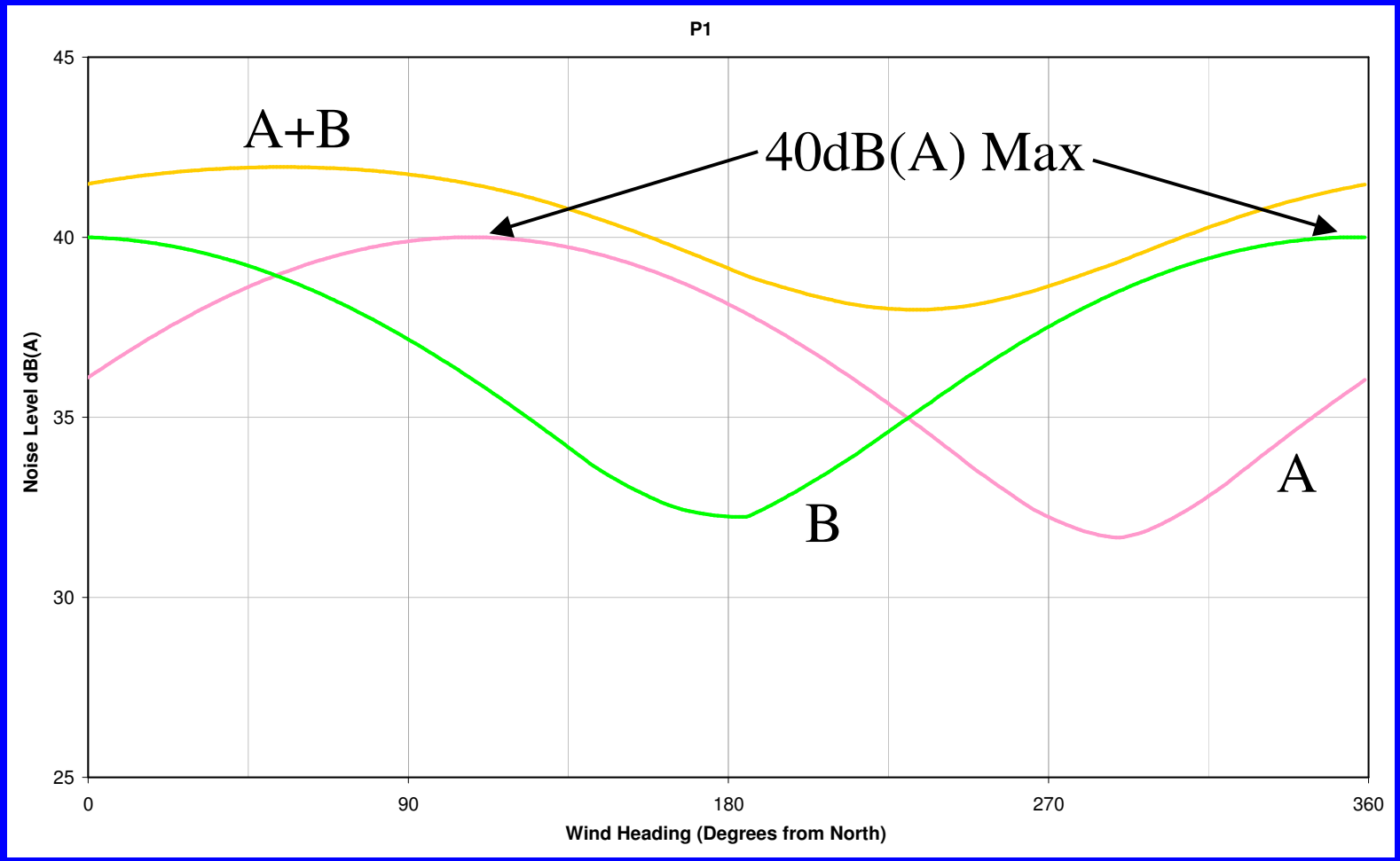
Caution!

- These directivity functions will only be reasonable for propagation distances which are ‘far-field’
- This will depend on the source height – approximately 400m or more

HOARE LEA ACOUSTICS

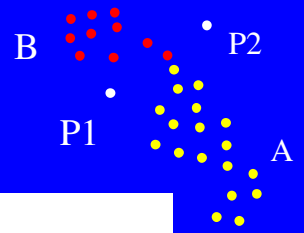
Noise Levels (P1)

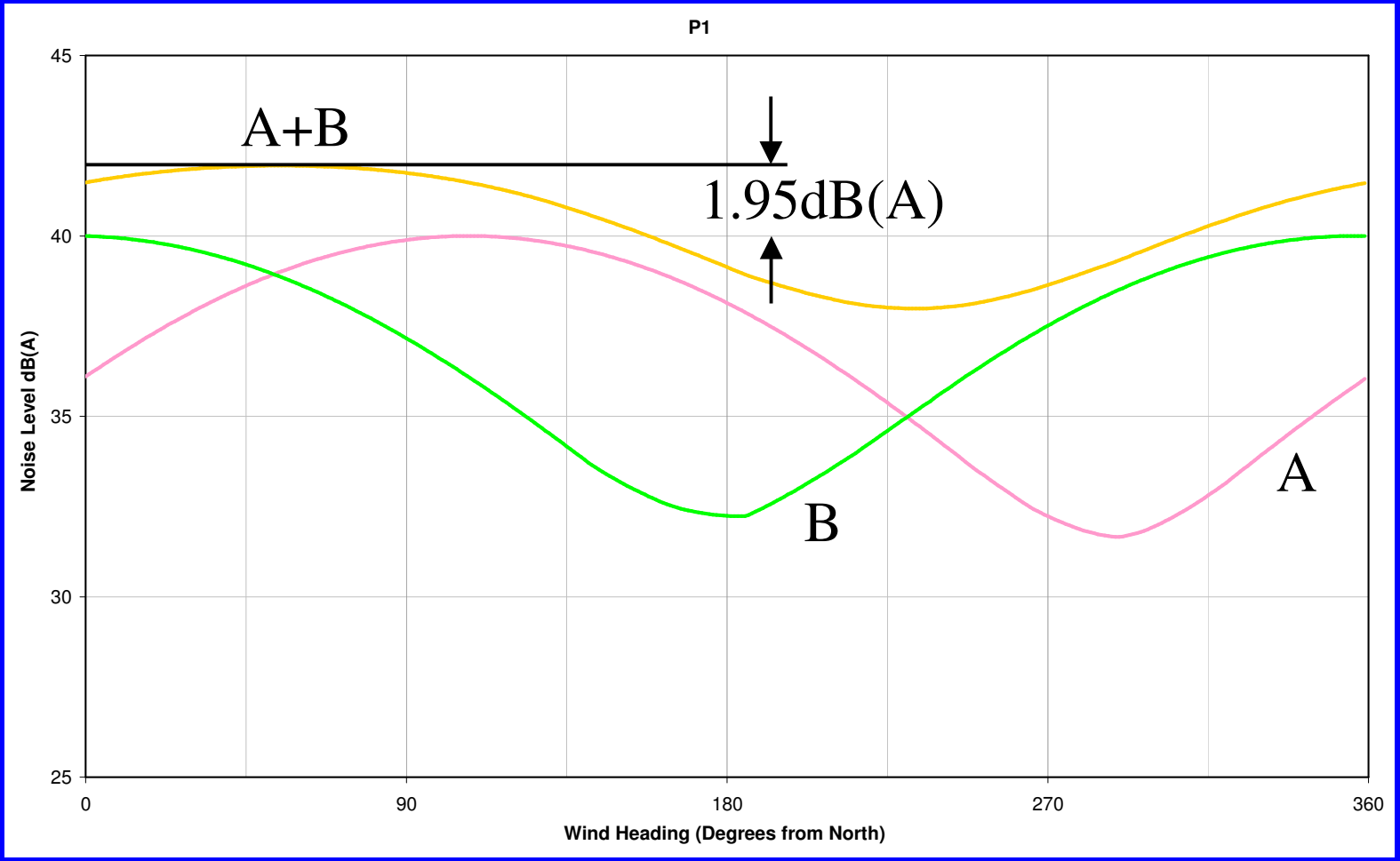




Directivity Function #3

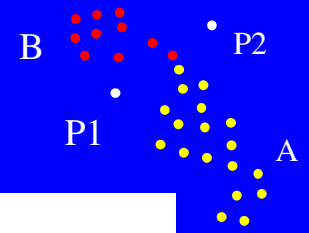
Noise Levels (P1)

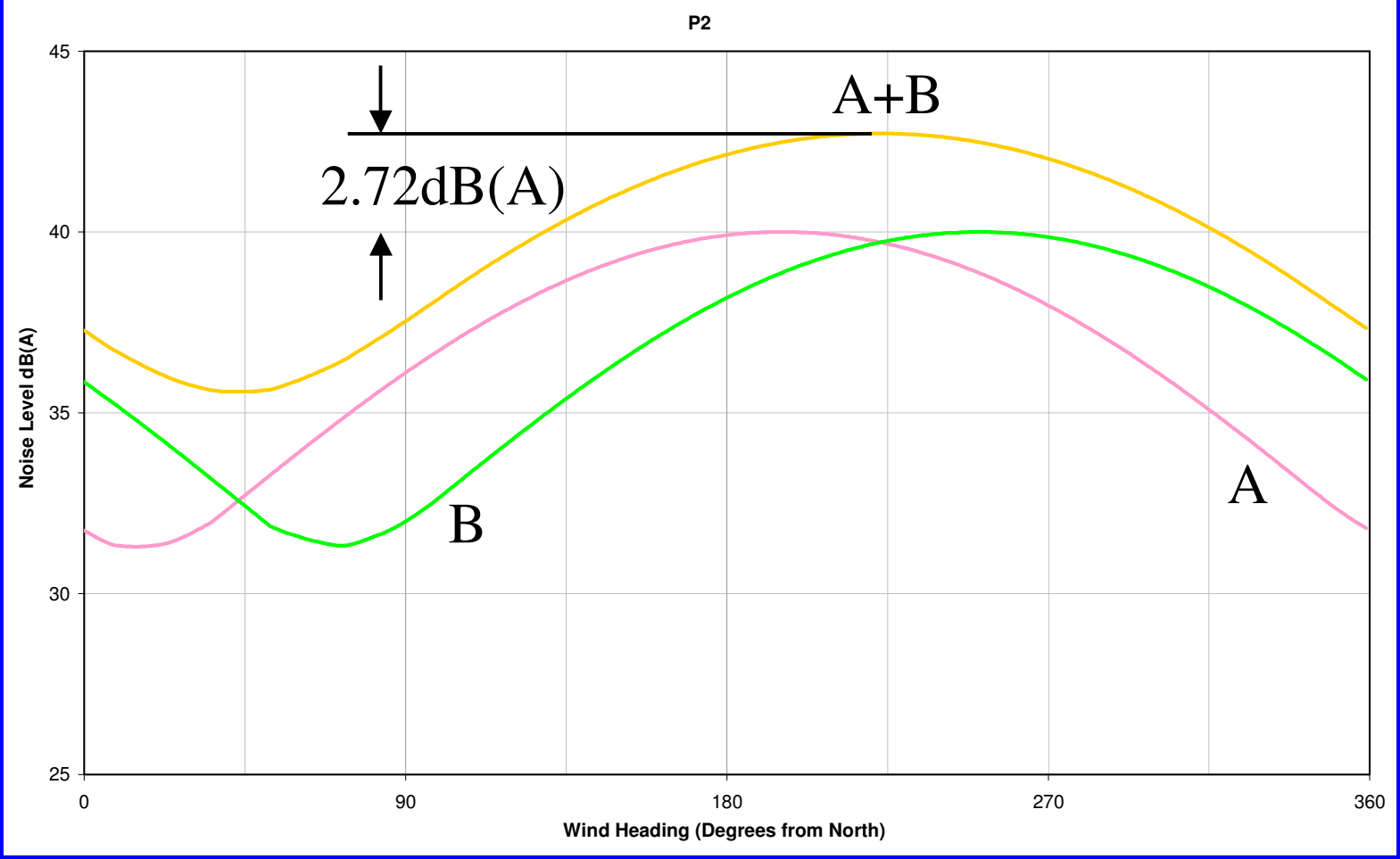




Directivity Function #3

Noise Levels (P2)





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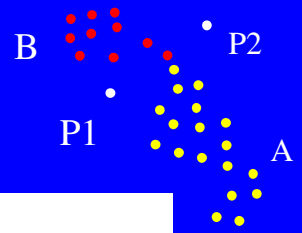
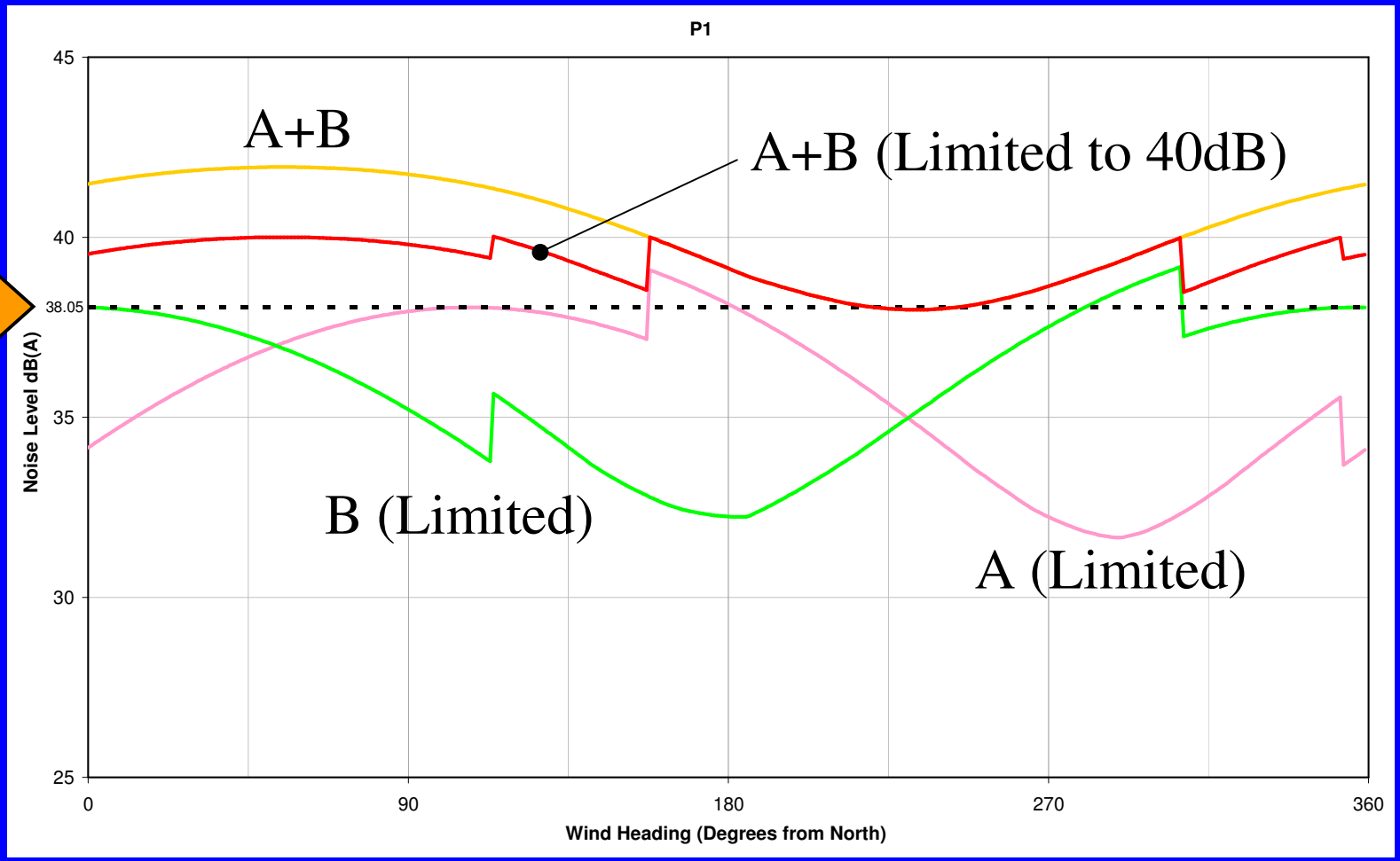
Directivity Function #3

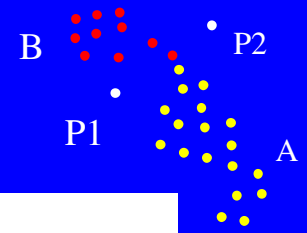
Noise Limited (P1)

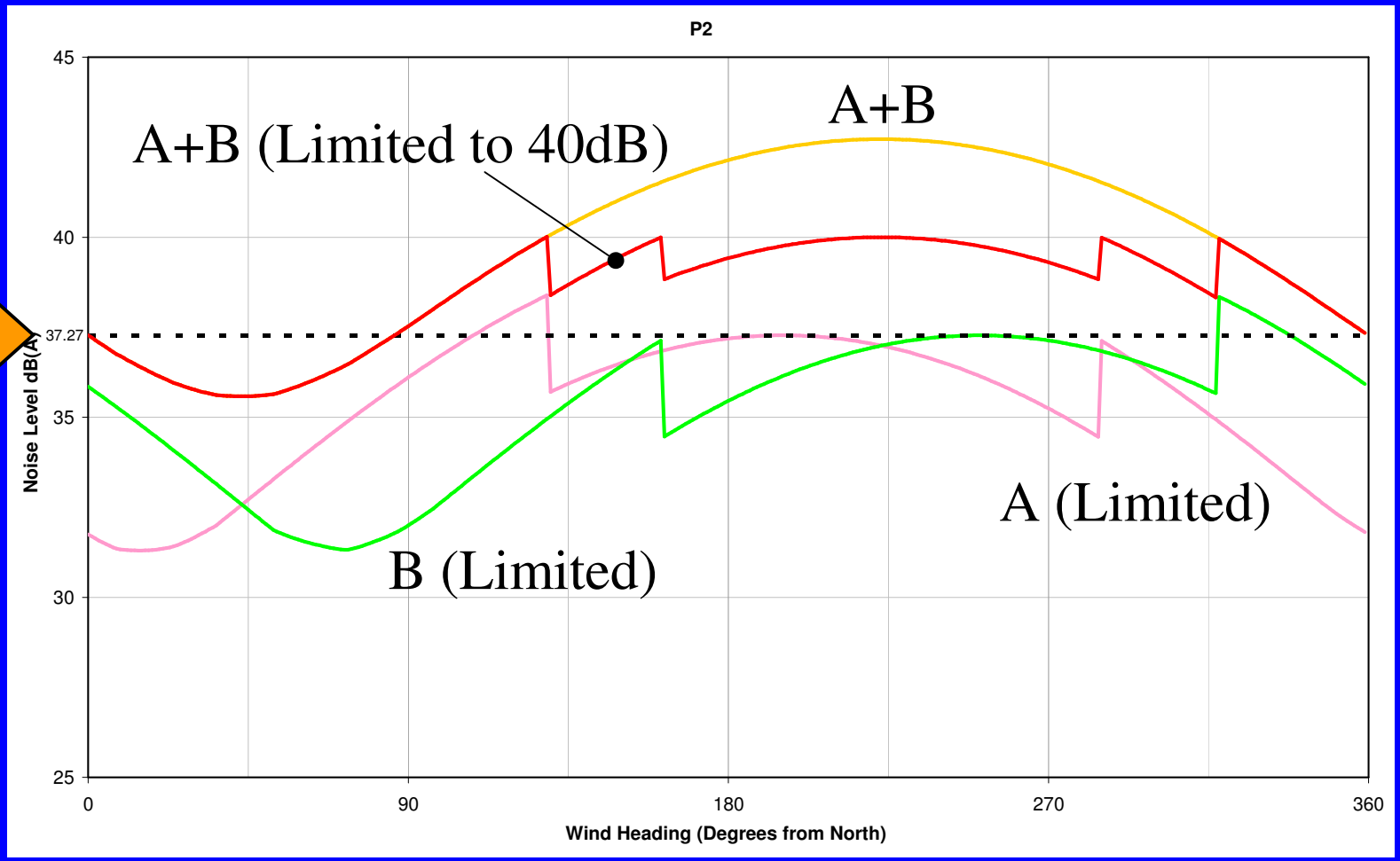




Directivity Function #3

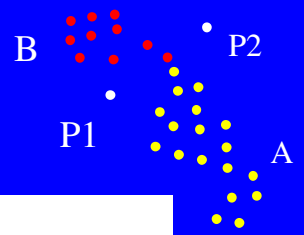
Noise Limited (P2)

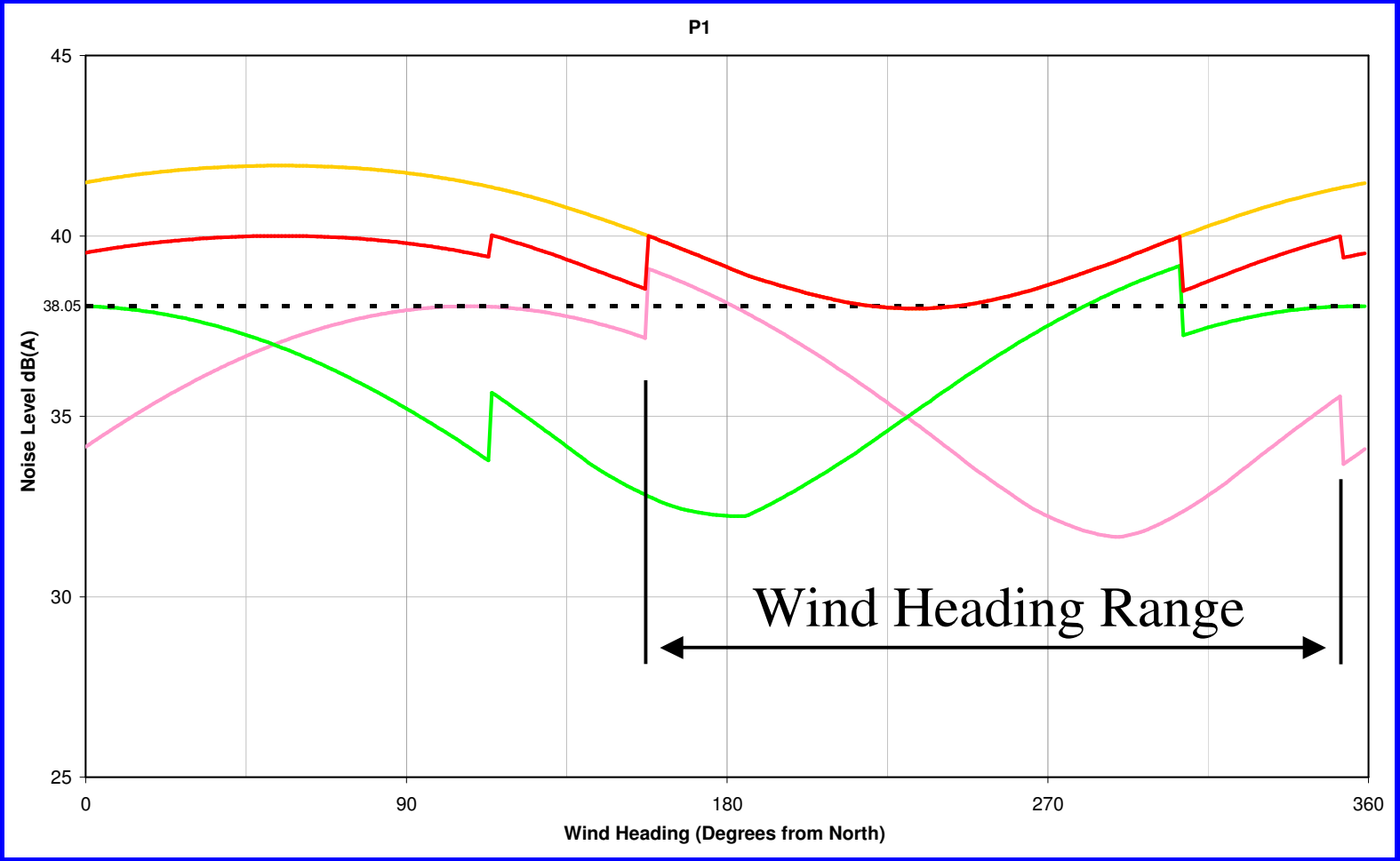




Directivity Function #3

Noise Limited (P1)





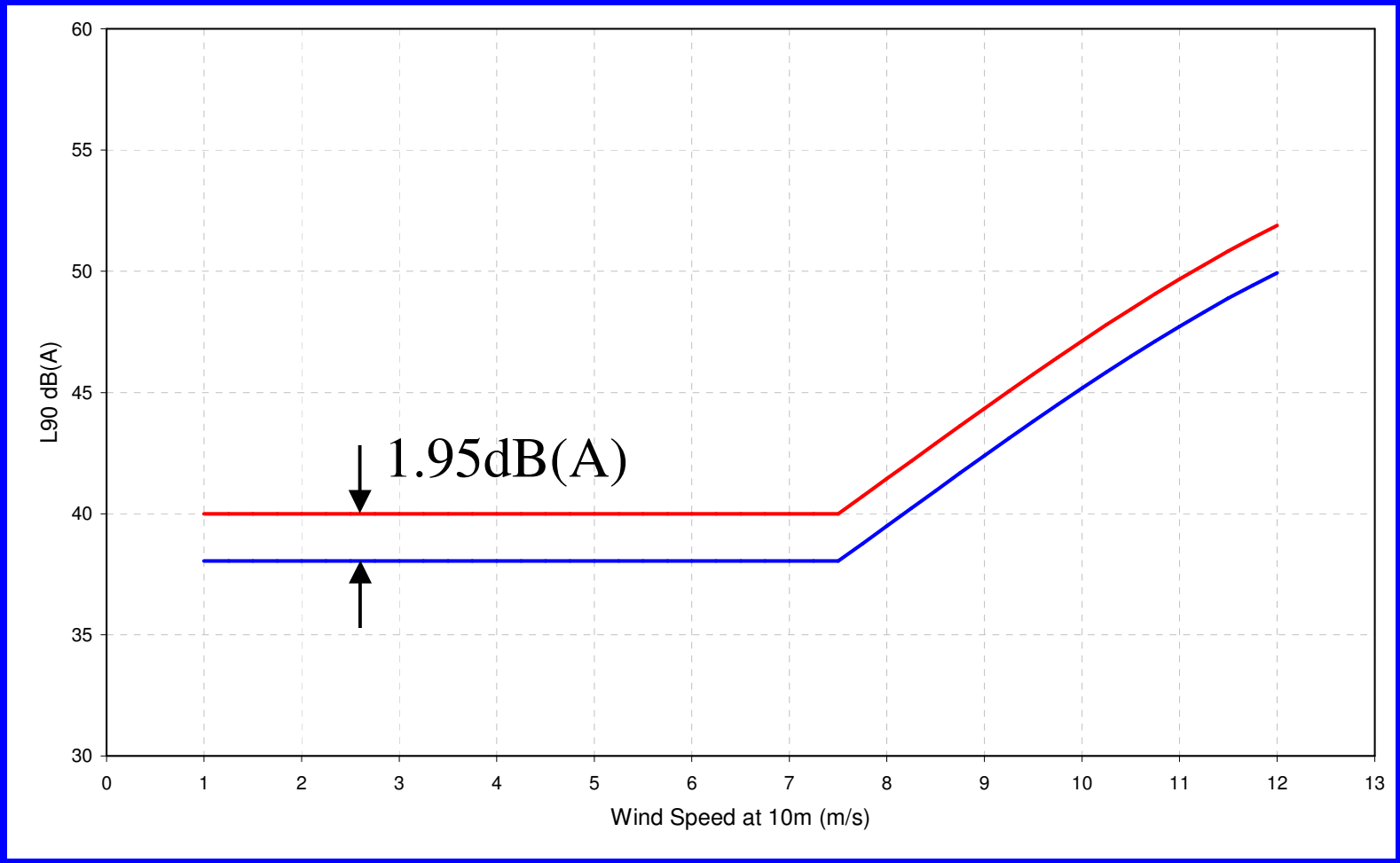
Directivity Function #3

Cumulative Noise Limits

- Use the reductions at each location to reduce the actual limits

HOARE LEA ACOUSTICS

Actual Noise Limits (P1)



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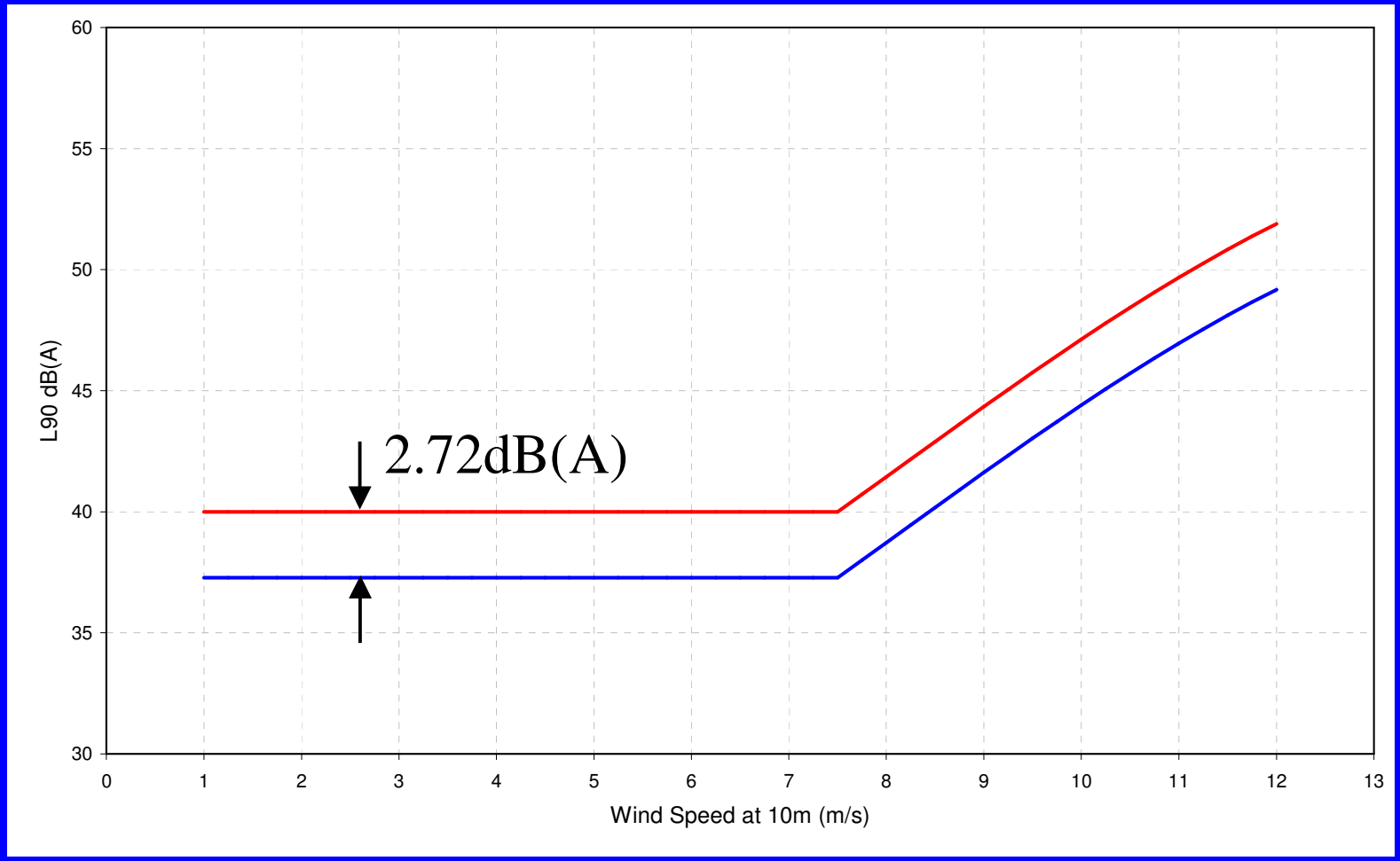
Directivity Function #3

Actual Noise Limits (P2)



HOARE LEA ACOUSTICS

Directivity Function #3

Cumulative Noise Limits

- Use the reductions at each location to reduce the actual limits

HOARE LEA ACOUSTICS

Cumulative Noise Limits

- Use the reductions at each location to reduce the actual limits
- Use the range of wind headings to limit the use of these lower limits to specific wind directions

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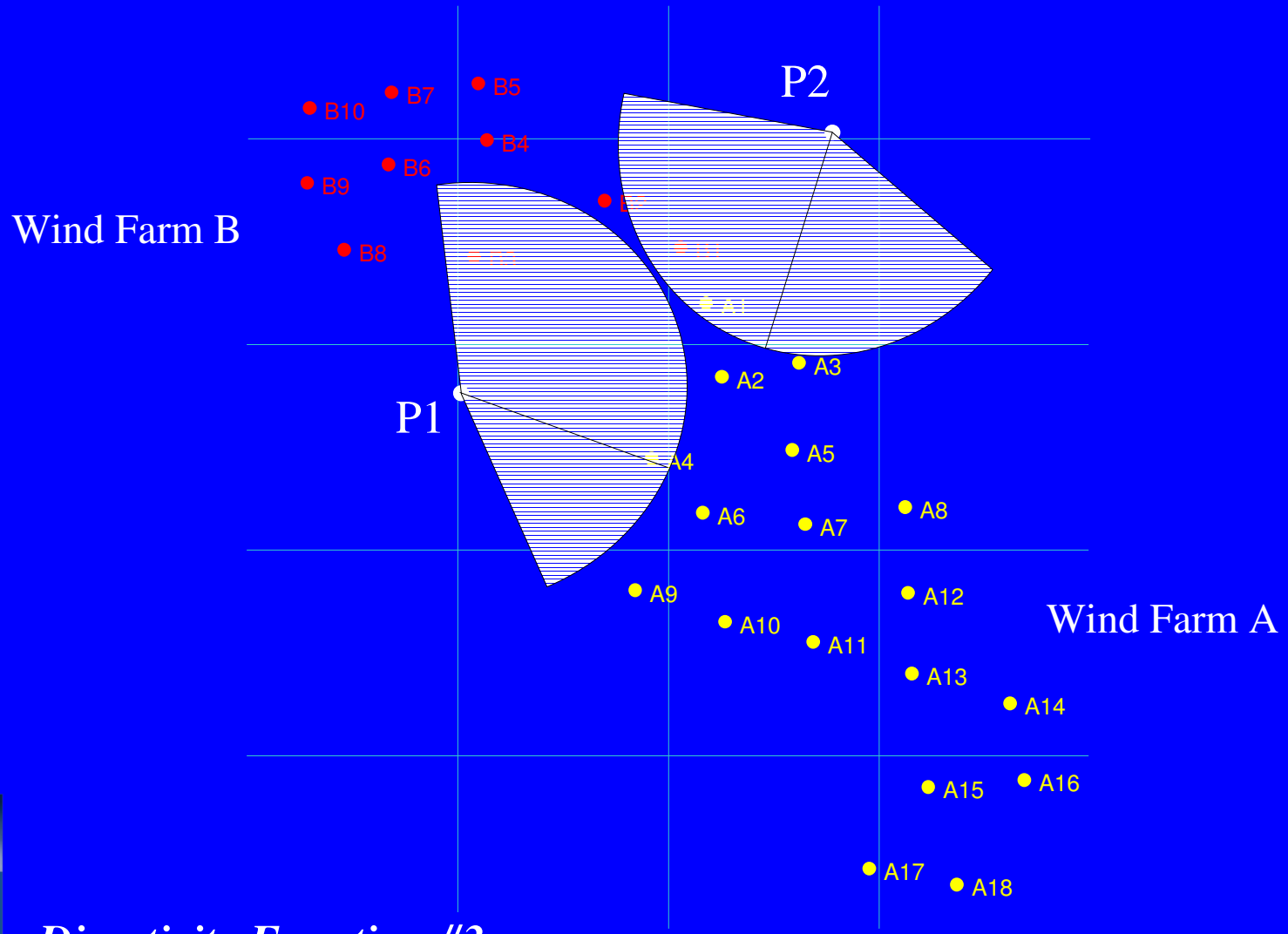
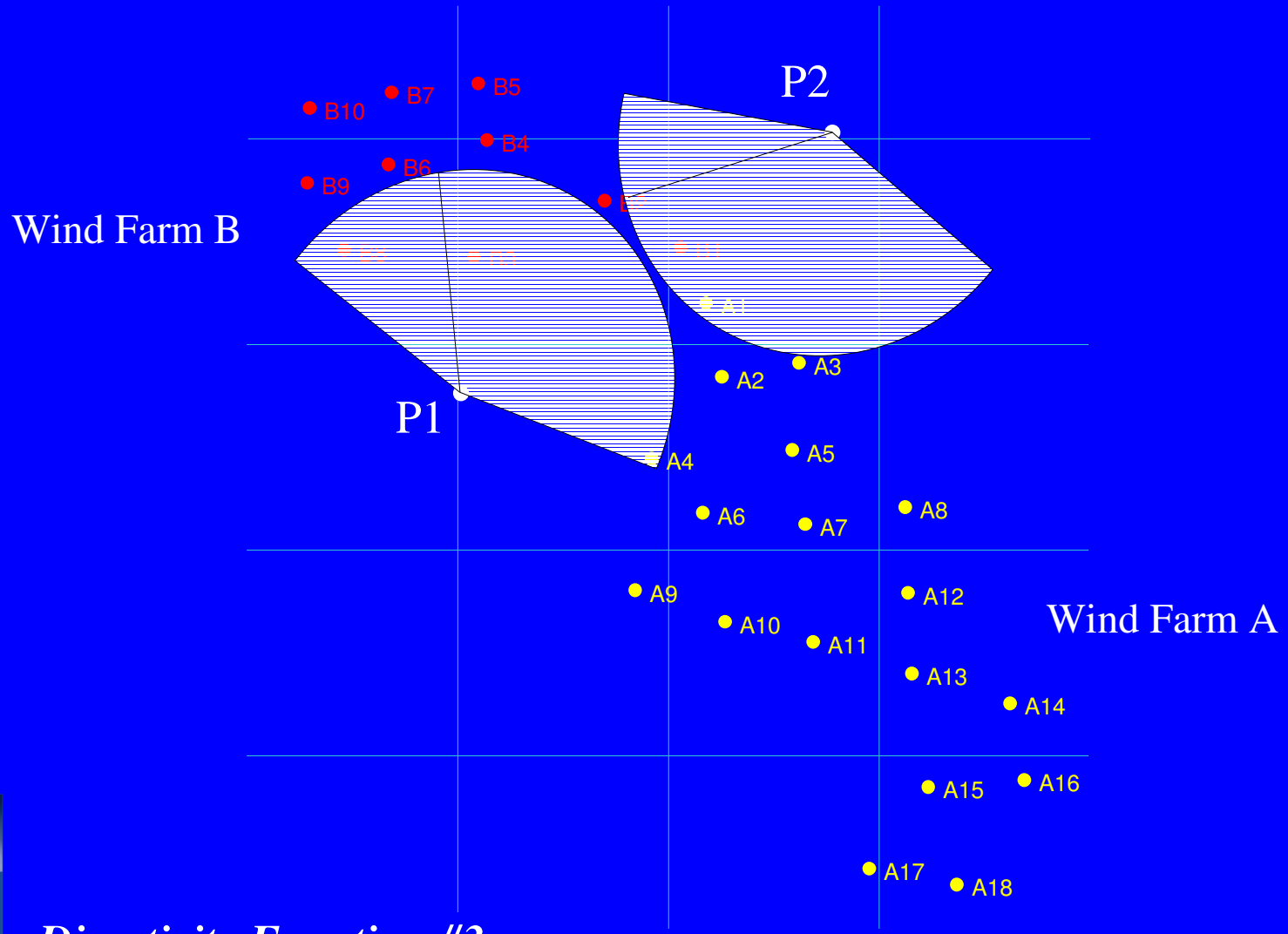
Wind Headings (Wind Farm A)



Directivity Function #3

Wind Headings (Wind Farm B)



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Directivity Function #3

Cumulative Noise Limits

Noise from [Wind Farm A] during the night-time (2300hrs to 0700hrs) shall not exceed:

	[2] Wind Speed (m/s)										
Location	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
P1											
P1 for wind directions from ----º to ----º [1]											
P2											
P2 for wind directions from ----º to ----º [1]											

and at all other times shall not exceed:

	[2] Wind Speed (m/s)										
Location	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
P1											
P1 for wind directions from ----º to ----º [1]											
P2											
P2 for wind directions from ----º to ----º [1]											

[1] To apply only subject to the operation of the adjacent [Wind Farm B].
[2] Wind speeds shall be those calculated at 10m height from those at hub height.

HOARE LEA ACOUSTICS

Planning Conditions

- The ‘test’ of a valid planning condition
  1. Necessary
  2. Relevant to planning
  3. Relevant to the development to be permitted
  4. Enforceable
  5. Precise
  6. Reasonable in all other respects

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